Grenzflächen-technik

Contact angle and surface characteristics

Fraunhofer IGB

Research fields

Functional interfaces

Plasma technology

Functional surfaces and thin layers

Nano(bio)technology, Nanoparticles, CNT

Membranes

Interfacial physics

Surface analytics

IGVT University of Stuttgart

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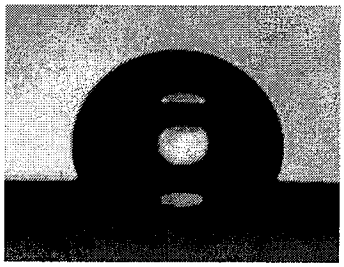
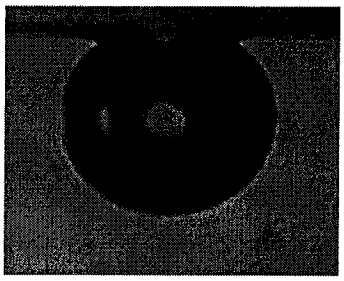
Contact angle measurement

The contact angle between a liquid and a solid is a measure of the energetic interaction between the solid and the liquid. This is usually determined using the sessile droplet method. A further possibility is the captive bubble method, which is suitable for materials which must be kept moist, such as biological samples or some membranes. In both cases, a tangent is drawn at the three-phase point, and its angle respective to the surface of the solid is defined as the contact angle. Alternatively, the contact angle can be determined from the droplet contour by means of various calculational methods (for example using the Young-Laplace equation).



Sessile droplet (water on polypropylene)

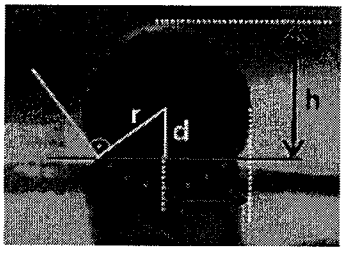
To determine the advancing angle, the measurements are performed while the volume of the droplet is being increased, thus increasing the liquid-solid interface area, This angle is generally larger than the receding contact angle, which is measured when the size of the droplet is being reduced. The difference between the advancing contact angle and the receding contact angle is referred to as the contact angle hysteresis. Its magnitude is dependent on the roughness, morphology and chemical homogeneity of the solid surface, and also on the molecular reorganization processes at the interface.



Captive bubble (air under water on polypropylene)

In the case of small droplets (up to a diameter of about 2 mm), it can be assumed that the shape of the droplet is spherical, to simplify the calculations.

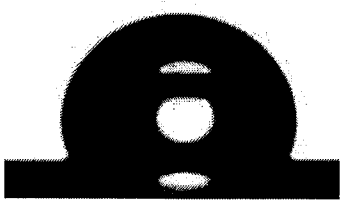
- More about our equipment for measurement of static and dynamic contact angles



Spherical droplet

Relationship between the contact angle and the surface characteristics

The contact angle depends on the chemical composition of the surface (the outer 0.5 to 1 nm of the interface is important) and on its topography. The contact angle is thus sensitive event to subtle changes of the surface. This is illustrated by the example on the left:



Water on untreated FEP film (110°)

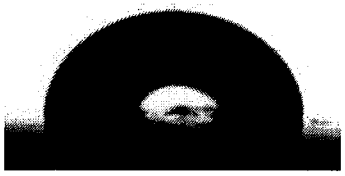
The surface of an FEP fluoropolymer film was in one case oxidized without changing the topography, and in the another case roughened without changing its chemical composition.

A smooth FEP surface has a contact angle of 110° for water. FEP can thus be classified as a hydrophobic material.

If the surface is oxidized by plasma treatment, the contact angle becomes less (87°), i.e. it becomes more wettable.

If the surface is roughened, without changing the chemical

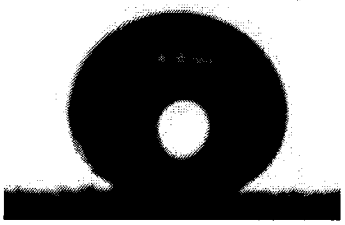
composition of the surface, the contact angle is increased considerably to 150°.



Water on oxidized FEP film (87°)

The very low wetting capability of rough surfaces of hydrophobic materials is also referred to as the lotus effect.

In the presence of surface-active substances, adsorption takes place on the liquid/air and solid/liquid interfaces . This can lead to a contact angle time dependency.



Water on roughened FEP film (150°)